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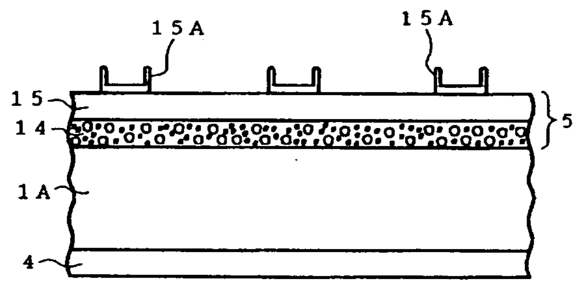
(54) Color cathode ray tube equipped with field leak preventing coating

(57) There is provided a field leak preventing coating film (5) of a cahtode ray tube, comprising a vacuum case comprising the panel section (1), a neck section (2) and a funnel section (3) connecting the panel section and the neck section; a fluorescent film (4) applied on an inner face of the panel section; and an electron gun (12), stored in the neck section, for emitting three electron beams (13) toward the fluorescent film, by adhering a double coating film composed of a conductive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and a second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) on an outer face of a faceplate of a panel section of the color cathode ray tube.

FIG. 3



Description

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a color cathode ray tube equipped with a field leak preventing coating film and more particularly to a color cathode ray tube equipped with a field leak preventing coating film adhering a double coating film composed of a conductive high-refractive first layer and a low-refractive second layer on the surface of a faceplate of a panel section.

Description of Related Art:

Hitherto, there has been known a cathode ray tube on which a double coating film composed a high-refractive first layer and a low-refractive second layer is adhered on the outer surface of a faceplate of a panel section to prevent glare on the faceplate, to prevent electric charge to prevent electrical shock from occurring in touching the faceplate and to contrast a displayed image.

Here, the anti-reflection function of the cathode ray tube having the conventional double coating film is achieved by interference of light caused by the double coating film.

The electrical charge preventing function for preventing the electrical shock of the cathode ray tube having the double coating film is achieved by reducing the surface sheet resistance (hereinafter abbreviated as a surface resistance) of the conductive high-refractive first layer to 10^4 to 10^8 Ω/□ by using the conductive high-refractive first layer into which conductive particles in which tin oxide (SnO_2) and antimony oxide (Sb_2O_3) are combined or conductive particles in which tin oxide (SnO_2) and indium oxide (In_2O_3) are combined for example is mixed as the high -refractive first layer within the double coating film composed of the high-refractive first layer and the low-refractive second layer.

Further, the function for highly contrasting the displayed image in the cathode ray tube having the conventional double coating film is achieved by mixing a certain amount of pigment of a specific color into the high-refractive first layer within the double coating film.

As the surface treatment film formed on the outer face of the faceplate of the panel section of such color cathode ray tube, there have been known 1) one which is obtained by forming a conductive film having a resistance of about 1 x 10^3 Ω/□ by means of sputtering, evaporation or the like to prevent electrical charge and to suppress leakage of electromagnetic wave and by forming thereon a multi-layered film in which a low-refractive film and a high-refractive film are laminated, 2) one which is obtained by forming a NESA coating film on the outer face of the panel by means of CVD or the like as a conductive film and by laminating thereon a high refractive film, or 3) one which is obtained by forming a conductive film by applying a solution in which particles of silver (Ag) whose specific resistance is low are dispersed by application means such as spin coating and by forming thereon a low-refractive layer made of silica (SiO_2) by applying by means of spin coating or the like.

It is noted that the technological means for achieving the above-mentioned functions have been disclosed in Japanese Patent Laid-Open Nos. Hei. 3-93136, Hei. 5-113505, Hei. 5-343008 and Hei. 7-312170.

Beside them, there has been also known a cathode ray tube which prevents an electric field generated within the cathode ray tube from leaking from the outer face of the faceplate of the panel section, i.e. a cathode ray tube having a field leak preventing coating film, by adhering and forming a double coating film composed of a high-refractive first layer and a low-refractive second layer on the outer face of the faceplate of the panel section and by using a conductive high-refractive first layer in which metal particles are mixed as the high-refractive first layer to reduce the surface resistance of the conductive high-refractive first layer to less than 1 x 10^3 Ω/□ and an example thereof is described in a magazine "Industrial Material" vol. 44, No. 9 (August, 1996) pp. 68-71.

By the way, the above-mentioned cathode ray tube having the double coating film has had a problem that although the conductive high-refractive first layer into which the conductive particles in which tin oxide (SnO_2) and antimony oxide (Sb_2O_3) are combined or the conductive particles in which tin oxide (SnO_2) and indium oxide (In_2O_3) are combined for example is mixed is used as the high- refractive first layer, it is unable to prevent the electric field generated within the cathode ray tube from leaking to the outside from the outer face of the faceplate of the panel section in the conductive high-refractive first layer because the surface sheet resistance of the conductive high-refractive first layer is 1 x 10^4 to 10^8 Ω/□.

The prior art cathode ray tube having the field leak preventing coating film also has had a problem that although it may be used as a cathode ray tube fully having the field leak preventing function because the surface sheet resistance of the conductive high-refractive first layer is less than 1x 10^3 Ω/□, the conductive high-refractive first layer causes aged degradation of the surface sheet resistance because the surface thereof is in an activ state and is apt to be oxidized because the conductive metal particles mixed in the conductive high-refractive first layer has a particle size of less than

100 nm.

The prior art cathode ray tube having the field leak preventing coating film has had another problem that although it allows a high contrast to be obtained by suppressing black color of a body color of the cathode ray tube which is caused by the double coating film composed of the conductive high-refractive first layer and the low-refractive second layer along the increase of reflection of external light on the fluorescent screen within the faceplate from standing out by the light absorptivity of the metal particles mixed into the conductive high-refractive first layer, the body color of the cathode ray tube is colored to a color other than black because a spectral transmittance of the mixed metal particle layer differs depending on wavelength of the light. For instance, when the spectral transmittance of the layer of the mixed metal particle is low around 420 nm of wavelength and shows a peak of absorption, the double coating film composed of the high-refractive first layer and the low-refractive second layer turns out to be amber color, a hue inadequate for the display.

The prior art color cathode ray tube having the structure 1) described above has had a problem that although it effectively prevents glare and electric charge and suppresses the leakage of electromagnetic wave, its production cost is remarkably high. The color cathode ray tube having the structure 2) described above has had a problem that it requires a number of steps for forming the NESA coat and the multi-layered film and that a desired performance cannot be fully obtained. The color cathode ray tube having the structure 3) described above has had a problem that it is difficult to maintain the initial performance for a long period of time, though its production cost is low.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a cathode ray tube equipped with a field leak preventing coating film which permits to prevent aged deterioration of a surface sheet resistance of a conductive high-refractive first layer within a double coating film composed of the conductive high-refractive first layer and a low-refractive second layer.

It is a secondary object of the present invention to provide a cathode ray tube equipped with a field leak preventing coating film which permits to prevent the aged deterioration of the surface sheet resistance of the conductive high-refractive first layer within the double coating film composed of the conductive high-refractive first layer and the low-refractive second layer and to prevent a body color of the cathode ray tube from being colored.

In order to achieve the first object, the inventive cathode ray tube having the field leak preventing coating film is provided with first means in which a conductive high-refractive first layer is formed by mixing particles of one or more metals among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) in adhering a double coating film composed of the conductive high-refractive first layer mainly composed of the metal particles and a low-refractive second layer.

According to the first means, because the particles of one or more metals among the noble metal elements of gold (Au), silver (Ag) or platinum (Pt) which are chemically stable are used as the metal particles of the conductive high-refractive first layer, the surface sheet resistance of the conductive high-refractive first layer may be reduced to 1 x 10^3 Ω/□ which exerts an field leakage preventing function and no aged deterioration of the surface sheet resistance of the conductive high-refractive first layer is caused in the same time.

Further, in order to achieve the second object, an inventive cathode ray tube having the field leak preventing coating film is provided with second means by adhering a double coating film composed of a conductive high-refractive first layer in which metal particles are mixed and a low-refractive second layer on the outer face of the faceplate of the panel section, by forming the conductive high-refractive first layer by mixing particles of one or more metals among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and by adding a coloring matter such as pigment and dye to the low-refractive second layer to exert a wavelength selective absorbing characteristic.

According to the second means, beside that the conductive high-refractive first layer has a low resistance of less than 1 x 10^3 Ω/□ which exerts the field leakage preventing function and that no aged deterioration of the surface sheet resistance occurs similarly to the first means described above, the body color of the cathode ray tube may be changed to achromatic color by adding the coloring matter which is complementary to the coloring of the body color of the cathode ray tube to the low-refractive second layer.

The color cathode ray tube of the present invention is characterized in that, as contrast to one in the prior art, it is provided with the low resistant conductive film formed by using a solution in which particles of chemically stable noble metals other than silver or a noble metal mixed dispersed solution in which a ratio of silver is reduced on the outer face of the faceplate.

The noble metals, except of silver, have a higher specific resistance than silver. Therefore, in order to obtain a desirable surface resistance, according to the present invention, the film is thickened to reduce the surface resistance and the drop of light transmittance in the visual range caused by the light absorbing characteristic intrinsic to the metal material due to the increase of the thickness is solved by using a faceplate having a high transmittance.

That is, a color cathode ray tube according to a first aspect of the invention comprises a vacuum case comprising a panel section in which a fluorescent film made of at least one color of fluorescent substance is formed on the inner

face thereof, a neck section in which an electron gun is stored and a funnel section connecting the panel section and the neck section. The color cathode ray tube also has a multi-layered surface treatment film composed of a conductive high-refractive film formed on the outer face of the panel section and a low-refractive film formed thereon. An average light transmittance of the visual range of the surface treatment film is 50 to 70 % and a surface resistance thereof is less than 1 x 10^3 Ω/□. By constructing as described above, the leakage of electromagnetic wave may be fully suppressed and the anti-reflection and electric charge preventing functions may be fully achieved.

A color cathode ray tube according to a second aspect of the invention is characterized in that the conductive high-refractive film in the cathode ray tube of the first aspect of the invention contains a mixture of particles of one or more noble metals except of silver or a mixture in which silver particles are mixed in the particles of noble metal.

Because the electrical resistance of the conductive film may be lowered by constructing as described above, the leakage of electromagnetic wave may be fully suppressed and the anti-reflection and electric charge preventing functions may be fully achieved.

Further, according to a third aspect of the invention, the particle of noble metal in the color cathode ray tube in the second aspect of the invention is either one of platinum, rhodium, rubidium, palladium, iridium and osmium.

Because the electrical resistance of the conductive film may be lowered by constructing as described above, the leakage of electromagnetic wave may be fully suppressed and the anti-reflection and electric charge preventing functions may be fully achieved.

According to a fourth aspect of the invention, the low-refractive film in the color cathode ray tube in the first, second or third aspect of the invention has a light scattering characteristic.

Because the resistance of the conductive film may be lowered by constructing as described above, the leakage of electromagnetic wave may be fully suppressed, readily clearing the international guideline of TCO, and the anti-reflection and electric charge preventing functions may be fully achieved.

Further, because the specific resistance of the above-mentioned noble metals other than silver is large, the thickness may be increased in order to have a conductive film having a desired resistance. The transmittance of the conductive film decreases by thickening the film. Then, the overall transmittance is set at a desired value by using a panel whose transmittance is large, or more concretely, a panel using a glass ground whose absorption coefficient is 0.001 to 0.03 mm^{-1} as shown in the cathode ray tube of a fifth aspect of the invention.

The transmittance of the faceplate may be arbitrarily set and a panel having a desired contrast may be constructed by selecting the thickness of the above-mentioned conductive film or the absorption coefficient of the panel glass. Further, an external reflection curve may be flattened by thickening the conductive film and the coloring caused by the transmittance which differs depending on wavelength of light and reflection of body color of the fluorescent substance may be reduced, allowing a high image quality color cathode ray tube to be obtained.

The specific nature of the invention, as well as other objects, uses and advantages thereof, will clearly appear from the following description and from the accompanying drawings in which like numerals refer to like parts.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic sectional structural view showing a preferred embodiment of an inventive cathode ray tube having a field leak preventing coating film;

FIG. 2 is a sectional structural view showing part of a double coating film used for the cathode ray tube of the first embodiment;

FIG. 3 is a sectional structural view showing part of a double coating film used for the cathode ray tube of a second embodiment;

FIG. 4 is a sectional structural view showing part of a double coating film used for the cathode ray tube of a third embodiment;

FIG. 5 is a sectional structural view showing part of a double coating film used for the cathode ray tube of a fourth embodiment;

FIG. 6 is a flow chart showing steps for coating and forming the double coating film of the first embodiment on a faceplate;

FIG. 7 is a flow chart showing steps for coating and forming the double coating film of the second embodiment on a faceplate;

FIG. 8 is a flow chart showing steps for coating and forming the double coating film of the third embodiment on a faceplate;

FIG. 9 is a flow chart showing steps for coating and forming the double coating film of the fourth embodiment on a faceplate;

FIG. 10 is a characteristic chart showing a spectral transmittance of the color cathode ray tube having the double coating film of the first embodiment;

FIG. 11 is a characteristic chart showing a spectral transmittance of the color cathode ray tube having the double

coating film of the fourth embodiment;

FIG. 12 is a characteristic chart showing a spectral transmittance of the color cathode ray tube having the double coating film of a fifth embodiment;

FIG. 13 is a graph showing a relationship between a transmittance of a surface treatment film in a visual range and a surface resistance thereof according to sixth and seventh embodiment of the present invention;

FIG. 14 is a graph showing a result of measurement of the surface resistance of the surface treatment film of the color cathode ray tube and an amount of leak of electromagnetic wave according to sixth, seventh and eighth embodiment of the present invention;

FIG. 15 is a table for explaining the electromagnetic wave leak preventing effect of the surface treatment film of the color cathode ray tube of the sixth, seventh and eighth embodiments of the present invention as compared numerically with an international guideline (TCO of Sweden);

FIG. 16 is a table for explaining a cost for forming the surface treatment film of the color cathode ray tube of the sixth, seventh and eighth embodiments of the present invention as compared to a cost for forming a sputtering film and a NESA coat;

FIG. 17 is a schematic section view of a panel for explaining a transmittance of the panel of the color cathode ray tube;

FIG. 18 is a table for explaining a transmittance of various glass materials for composing the panel, a transmittance of the treatment film formed thereon and a total transmittance of the treatment film and the glass; and

FIG. 19 is a table for explaining a transmittance of a prior art color cathode ray tube.

DESCRIPTION OF PREFERRED EMBODIMENTS

According to embodiments of the present invention, a cathode ray tube having a field leak preventing coating film is what a double coating film composed of a conductive high-refractive first layer whose main component is metal particles and a low-refractive second layer whose main component is silicon oxide (SiO_2) or magnesium fluoride (MgF_2) is adhered on the outer face of a faceplate of a panel section and one or more metals among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) are used as the metal particles in the conductive high-refractive first layer.

According to one aspect of the present invention, the conductive high-refractive first layer of the above-mentioned embodiment is arranged so as to have a light absorbing characteristic and a light transmittance in the visual range in a range from 50 to 90 %.

According to another aspect of the present invention, the low-refractive second layer of the above-mentioned embodiment is arranged so as to have a selective wavelength absorbing characteristic by adding a coloring material such as pigment and dye.

According to one preferred embodiment of the present invention, the above-mentioned double coating film of the invention is formed by applying a solution in which the metal particles for forming the conductive high-refractive first layer are dispersed on the outer face of the faceplate of the panel section, by drying the applied surface to form the conductive high-refractive first layer, by applying an alcohol solution for forming the low-refractive second layer on the conductive high-refractive first layer and by sintering the applied surface in a temperature range of 160 to 175°C to form the low-refractive second layer.

According to another preferred embodiment of the present invention, the above-mentioned double coating film of the invention is formed by applying the dispersed solution of metal particles for forming the conductive high-refractive first layer on the outer face of the faceplate of the panel section, by heating and drying the applied surface within a temperature range of 70 to 130°C to adhere and form the conductive high-refractive first layer, by applying an alcohol solution for forming the low-refractive second layer on the conductive high-refractive first layer and by sintering the applied surface in a temperature range of 160 to 175°C to form the low-refractive second layer.

According to the above-mentioned embodiment of the present invention, because the particles of one or more kinds of metal among the chemically stable noble metals of gold (Au), silver (Ag) or platinum (Pt) is used as the metal particles used in the conductive high-refractive first layer in adhering the double coating film composed of the conductive high-refractive first layer mainly composed of the metal particles and the low-refractive second layer on the outer face of the faceplate of the panel section of the cathode ray tube, the surface sheet resistance of the conductive high-refractive first layer may be reduced to as low as less than 1×10^3 Ω/□ and no deterioration of the surface sheet resistance of the conductive high-refractive first layer occurs for a long period of time.

According to the other embodiment of the present invention, the coloring matter such as pigment and dye which is complementary to the coloring of the body color of the cathode ray tube is added to the low-refractive second layer, so that the coloring of the body color of the cathode ray tub may be complemented and may be turned to achromatic color.

The embodiments of the present invention will be explained below with reference to the drawings.

FIG. 1 is a schematic section view for explaining the embodiment of the inventive color cathode ray tube, compris-

ing a panel section 1, a faceplace 1A, a neck section 2, a funnel section 3, a fluorescent film 4, a double coating film 5, a shadow mask 6, an internal magnetic shield 7, a deflection yoke 8, a purity control magnet 9, a center beam static convergence control magnet 10, a side beam static convergence control magnet 11, an electron gun 12, an electron beam 13, a mask frame 16, a mask suspension mechanism 17, an internal conductive layer 18, a shield cup 19, a contact spring 20, a getter 21 and a stem pin 22.

That is, the color cathode ray tube comprises a vacuum case formed by the panel section 1, the neck section 2 and the funnel section 3 connecting the panel section 1 and the neck section 2, the fluorescent film 4 formed on the inner face of the panel section 1 and composed of three fluorescent substances, the electron gun 12 stored within the neck section 2 and the deflecting yoke 8 sheathing the transition area of the funnel to the neck section 2. It is noted that the purity control magnet 9, the center beam static convergence control magnet 10 and the side beam static convergence control magnet 11 are disposed in parallel at the outside of the neck section 2.

The shadow mask which is a color selection electrode fixed to the mask frame 16 is suspended and held to the inner wall of the skirt of the panel section 1 in close proximity to the fluorescent film 4 by the mask suspension mechanism 17 within the panel section 1. It is noted that the internal magnetic shield 7 which shields the electron beam 13 from the external magnetic field is fixed to the mask frame 16. Three electron beams (only one beam is shown in FIG. 1) emitted from the electron gun 12 is deflected in a predetermined direction by the deflection yoke 8 and then impinges against the fluorescent film 4 via an electron beam pass hole not shown of the shadow mask 6.

The internal conductive layer 18 such as a graphite film is applied from the panel section 1 to the neck section 2 to supply anodic voltage applied from an anode button not shown provided through the funnel section 3 to a conductive thin film not shown formed on the back of the fluorescent film 4 and to an anode electrode of the electron gun 12. This anodic voltage is supplied to the electron gun 12 via a contact spring 20 attached to the shield cup 19.

The double coating film 5 having functions for preventing reflection of external light, for preventing electric charge and for suppressing radiation of electromagnetic wave is formed on the faceplace 1A which is the outer face composing the screen of the panel section 1.

The double coating film 5 has a double-layered structure having the functions for enhancing the contrast of images, for preventing reflection of external light, for preventing electric charge and for suppressing radiation of electromagnetic wave.

Because the operation of the color cathode ray tube constructed as described above, i.e. the image displaying operation, is totally the same with the image displaying operation of the known color cathode ray tube, its explanation will be omitted here.

[First Embodiment]

FIG. 2 is a sectional structural view showing part of the first embodiment of the double coating film 5 used in the color cathode ray tube of the present embodiment shown in FIG. 1. In FIG. 2, the double coating film 5 comprises a conductive high-refractive first layer 14 and a low-refractive second layer 15, beside the components shown in FIG. 1 which are denoted by the same reference numerals.

That is, the double coating film 5 comprises the conductive high-refractive first layer 14 whose main component is silver particles coated and formed on the faceplace 1A of the panel section 1 and the low-refractive second layer 15 made of silicon oxide (SiO_2) coated and formed on the conductive high-refractive first layer 14. A thickness of the conductive high-refractive first layer 14 is about 40 nm and that of the low-refractive second layer 15 is about 70 nm.

FIG. 6 is a flow chart showing a procedure for coating and forming the double coating film 5 of the present embodiment on the faceplace 1A. The steps for forming the double coating film 5 of the present embodiment will be explained her by using the flow chart.

At first, a reinforcing fitting is attached around the panel section 1 of the color cathode ray tube in Step S1. Next, the surface of the faceplace 1A of the panel section 1 of the color cathode ray tube is polished by abrasive in Step S2.

Then, the polished faceplate 1A is rinsed by showering city water or pure water in Step S3. The rinsed faceplate 1A of the panel section 1 is dried in Step S4.

Next, temperature of the surface of the panel section 1 is set so as to be about 40°C in Step S5.

Then, an aqueous dispersed solution (metal particle dispersed solution) composed of high boiling solvent having solid component of silver (Ag) particles is spin-coated on the faceplace 1A of the panel section 1 to coat the conductive high-refractive first layer 14 in Step S6.

In succession, the faceplace 1A is heated at temperature of about 100°C to dry the conductive high-refractive first layer 14 thus coated in Step S7.

Then, an alcohol solution of silicon alkoxide is spin-coated on the conductive high-refractive first layer 14 to coat the low-refractive second layer 15 while setting the surface temperature of the panel section 1 at about 40°C in Step S8.

Then, the d uble coating film 5 is formed on the faceplace 1A of the panel section 1 by sintering the low-refractive second layer 15 by heating the faceplace 1A at temperature of about 165°C in Step S9.

FIG. 10 is a characteristic chart showing a spectral transmittance of the color cathode ray tube having the double coating film 5 of the present embodiment obtained through the fabrication steps described above, wherein the vertical axis represents light transmittance shown by % and the horizontal axis represents wavelength of light shown by nm.

As shown in FIG. 10, although the color cathode ray tube having the double coating film 5 of the present embodiment shows light absorptivity slightly in the vicinity of 420 nm of light wavelength, it is almost flat in the visual range. When light transmission color of the color cathode ray tube having the double coating film 5 of the present embodiment is represented in accordance to "Method for Displaying Color of Object by L'a'b' Color Specification System and L'u'v' Color Specification System" described in JIS C8729, a' = -2 to +2 and b' = 0 to +4 and the appearance of the faceplace 1A of the panel section 1 has been evaluated as what is close to achromatic color by naked eyes. Further, the color cathode ray tube having the double coating film 5 of the present embodiment has a surface sheet resistance of about 500 Ω/□, a leaked field strength of 0.5 V/m in ELEF (frequency band of 5 Hz to 2 KHz) and of 0.5 V/m in VLEF (frequency band of 2 KHz to 400 KHz) and fully satisfies the TCO Standard which is most rigorous to leaked field strength.

Beside them, the color cathode ray tube having the double coating film 5 of the present embodiment has a visual reflectance of 0.7 % and a light transmittance in the visual range of 72 % and cancels black color of the body color of the color cathode ray tube, caused by the anti-reflection effect, from standing out.

[Second Embodiment]

FIG. 3 is a sectional structural view showing a second embodiment of the double coating film 5 of the color cathode ray tube shown in FIG. 1. In FIG. 3, while there is shown a low refractive third layer 15A, the same components with those shown in FIGs. 1 and 2 are denoted by the same reference numerals.

In this case, the double coating film 5 comprises the conductive high-refractive first layer 14 whose main component is silver particles coated and formed on the faceplace 1A of the panel section 1, the low-refractive second layer 15 made of silicon oxide (SiO_2) coated and formed on the conductive high-refractive first layer 14 and the low-refractive second layer 15A made of silicon oxide (SiO_2) formed partially on the low-refractive second layer 15 so as to have irregular surface. The thickness of the conductive high-refractive first layer 14 is about 40 nm, the thickness of the low-refractive second layer 15 is about 70 nm and the thickness of the low-refractive second layer 15A is about 10 nm at the thickest part.

Because the irregular low-refractive third layer 15A is provided in the color cathode ray tube having the double coating film 5 of the present embodiment, the low-refractive second layer 15A scatters external light slightly, allowing to reduce mirror reflection which cannot be fully reduced otherwise only by the anti-reflection effect of the double coating film 5.

FIG. 7 is a flow chart showing a procedure for coating and forming the double coating film 5 of the second embodiment on the faceplace 1A. The procedure for forming the double coating film 5 of the present embodiment will be explained below by using the flow chart.

Steps S1 through S8 are the same with those in the procedure for forming the double coating film 5 described in the first embodiment.

Then, the faceplace 1A is heated at temperature of about 60°C to dry the low-refractive second layer 15 in Step S10.

Next, an alcohol solution of silicon alkoxide whose composition is different from the alcohol solution used in Step S8 is spin-coated partially on the low-refractive second layer 15 to coat the low-refractive second layer 15A while setting the temperature of the panel section 1 at about 50°C in Step S11.

Then, the double coating film 5 is formed on the faceplace 1A of the panel section 1 by sintering the low-refractive second layer 15 and the low-refractive second layer 15A respectively by heating the faceplace 1A at temperature of about 165°C in Step S12.

The spectral transmittance of the color cathode ray tube having the double coating film 5 of the present embodiment is almost the same with that of the color cathode ray tube having the double coating film 5 of the first embodiment shown in FIG. 10. Further, the light transmission color of the color cathode ray tube having the double coating film 5 of the present embodiment is a' = -2 to +2 and b' = 0 to +4, which is almost the same with that of the color cathode ray tube having the double coating film 5 of the first embodiment. The appearance of the faceplace 1A of the panel section 1 has been evaluated also as what is close to achromatic color by naked eyes. Still more, the color cathode ray tube having the double coating film 5 of the present embodiment has a surface sheet resistance of about 200 Ω/□, a leaked field strength of 0.4 V/m in ELEF and of 0.6 V/m in VLEF and fully satisfies the TCO standard.

Beside them, the color cathode ray tube having the double coating film 5 of the present embodiment has a visual reflectance of 0.8 % and a light transmittance in the visual range of 60 % and cancels black color of the body color of the color cathode ray tube, caused by the anti-reflection effect, from standing out.

[Third Embodiment]

FIG. 4 is a sectional structural view showing a third embodiment of the double coating film 5 of the color cathode ray tube shown in FIG. 1. In FIG. 4, while there are shown convex portions 14A of the conductive high-refractive first layer 14a, the same components with those shown in FIGs. 1 and 2 are denoted by the same reference numerals.

In the present embodiment, the double coating film 5 comprises the conductive high-refractive first layer 14 whose main component is silver particles coated and formed on the faceplace 1A of the panel section 1 and which has the conductive high-refractive first layer 14A partially and the low-refractive second layer 15 made of silicon oxide (SiO_2) coated and formed on the conductive high-refractive first layer 14 containing the convex portions 14A. The thickness of the conductive high-refractive first layer 14 at the flat part is about 30 nm, the thickness of the convex portion 14A is about 15 nm at the thickest part and the thickness of the low-refractive second layer 15 is about 70 nm.

Because the convex portions 14A are provided partially on the conductive high-refractive first layer 14 in the color cathode ray tube having the double coating film 5 of the present embodiment, those convex portions 14A scatter external light slightly, allowing to reduce mirror reflection which cannot be otherwise fully reduced only by the anti-reflection effect of the double coating film 5 similarly to the color cathode ray tube having the double coating film 5 of the second embodiment.

FIG. 8 is a flow chart showing a procedure for coating and forming the double coating film 5 of the present embodiment on the faceplace 1A. The procedure for forming the double coating film 5 of the present embodiment will be explained below by using the flow chart.

Steps S1 through S4 are the same with those in the procedure for forming the double coating film 5 described in the first embodiment.

~~Then, the temperature of the surface of the panel section 1 is set so as to be about 55°C in Step S13.~~

Then, an aqueous dispersed solution (metal particle dispersed solution) composed of high boiling solvent containing solid component of silver (Ag) particles is spin-coated on the faceplace 1A of the panel section 1 to coat the conductive high-refractive first layer 14 partially having the convex portions 14A in Step S14.

In succession, the faceplace 1A is heated at temperature of about 75°C to dry the conductive high-refractive first layer 14 thus coated and having the convex portions 14A in Step S16.

Next, an alcohol solution of silicon alkoxide is spin-coated partially to the conductive high-refractive first layer 14 having the convex portions 14A to coat the low-refractive second layer 15 while setting the temperature of the panel section 1 at about 40°C in Step S16.

Then, the double coating film 5 is formed on the faceplace 1A of the panel section 1 by sintering the low-refractive second layer 15 by heating the faceplace 1A at temperature of about 165°C in Step S17.

The spectral transmittance of the color cathode ray tube having the double coating film 5 of the present embodiment is almost the same with that of the color cathode ray tube having the double coating film 5 of the first embodiment shown in FIG. 10. Further, the light transmission color of the color cathode ray tube having the double coating film 5 of the present embodiment is a' = -1 to +1 and b' = -1 to +1, which is almost the same with that of the color cathode ray tube having the double coating film 5 of the second embodiment. The appearance of the faceplace 1A of the panel section 1 is so close to achromatic color by naked eyes. Still more, the color cathode ray tube having the double coating film 5 of the present embodiment has a surface sheet resistance of about 800 $\Omega/\square$, a leaked field strength of 0.8 V/m in ELEF and of 0.8 V/m in VLEF, and fully satisfies the TCO Standard.

Beside them, the color cathode ray tube having the double coating film 5 of the present embodiment has a visual reflectance of 0.8 % and a light transmittance in the visual range of 65 %, and cancels black color of the body color of the color cathode ray tube, caused by the anti-reflection effect, from standing out.

[Fourth Embodiment]

FIG. 5 is a sectional structural view showing a fourth embodiment of the double coating film 5 of the color cathode ray tube shown in FIG. 1. In FIG. 5, the same components with those shown in FIGs. 1 and 2 are denoted by the same reference numerals.

In the present embodiment, the double coating film 5 comprises the conductive high-refractive first layer 14 whose main component is silver particles coated and formed on the faceplace 1A of the panel section 1 and the low-refractive second layer 15 made of silicon oxide (SiO_2) coated and formed on the conductive high-refractive first layer 14. The thickness of the conductive high-refractive first layer 14 is about 40 nm and the thickness of the low-refractive second layer 15 is about 70 nm.

FIG. 9 is a flow chart showing a procedure for coating and forming the double coating film 5 of the present embodiment on the faceplace 1A. The procedure for forming the double coating film 5 in the color cathode ray tube of the present embodiment will be explained below by using the flow chart.

Steps S1 through S6 are the same with those in the procedure for forming the double coating film 5 described in

the first embodiment.

Then, the faceplace 1A is heated at temperature of about 50°C to dry the conductive high-refractive first layer 14 in Step S18.

Next, an alcohol solution of silicon alkoxide is spin-coated on the conductive high-refractive first layer 14 to coat the low-refractive second layer 15 while setting the temperature of the panel section 1 at about 40°C in Step S19.

Then, the double coating film 5 of the present embodiment is formed on the faceplace 1A of the panel section 1 by sintering the low-refractive second layer 15 by heating the faceplace 1A at temperature of about 165°C in Step S20.

FIG. 11 is a characteristic chart showing a spectral transmittance of the color cathode ray tube having the double coating film 5 of the present embodiment obtained through the fabrication steps described above, wherein the vertical axis represents light transmittance shown by % and the horizontal axis represents wavelength of light shown by nm.

As shown in FIG. 11, although the color cathode ray tube having the double coating film 5 of the present embodiment shows light absorptivity in the vicinity of 420 nm of light wavelength which is slightly larger than those of the color cathode ray tube having the double coating film 5 of the first through third embodiments, it is almost flat in the visual range. Further, the light transmission color of the color cathode ray tube having the double coating film 5 of the present embodiment is a' = -3 to +3 and b' = +8 to +15, which is almost the same with that of the color cathode ray tube having the double coating film 5 of the first through third embodiments, though the light transmission color b shows a value which is slightly greater than that of the light transmission color b' of the color cathode ray tube having the double coating film 5 of the first through third embodiments. The appearance of the faceplace 1A of the panel section 1 is evaluated to be colored slightly in amber by naked eyes. Still more, the color cathode ray tube having the double coating film 5 of the present embodiment has a surface sheet resistance of about 500 Ω/□, a leaked field strength of 0.5 V/m in ELEF and of 0.4 V/m in VLEF, and fully satisfies the TCO Standard.

Beside them, the color cathode ray tube of the present embodiment has a visual reflectance of 0.7 % and a light transmittance in the visual range of 70 %, and cancels black color of the body color of the color cathode ray tube, caused by the anti-reflection effect, from standing out.

[Fifth Embodiment]

A double coating film 5 of a fifth embodiment may be obtained by dispersing a blue pigment, e.g. anthraquinone blue pigment, into the low-refractive second layer 15 of the double coating film 5 in the fourth embodiment. In the color cathode ray tube having the double coating film 5 of the present embodiment, the blue pigment which is the complementary color of amber is added to prevent the faceplace 1A of the color cathode ray tube having the double coating film 5 of the fourth embodiment from being color in amber.

The procedure for coating and forming the double coating film 5 of the present embodiment on the faceplace 1A is the same with the case of the color cathode ray tube of the fourth embodiment shown in FIG. 9 except of that alcohol solution in which the anthraquinone blue pigment of about 5 to 15 % to the content of the solid component of silicon alkoxide is added is used in Step S19 in coating and forming the double coating film 5 in the present embodiment.

FIG. 12 is a characteristic chart showing a spectral transmittance of the color cathode ray tube of the present embodiment, wherein the vertical axis represents light transmittance shown by % and the horizontal axis represents wavelength of light shown by nm. As shown in FIG. 12, in addition to that the color cathode ray tube of the present embodiment shows light absorptivity in the vicinity of 420 nm of light wavelength which is slightly larger than those of the color cathode ray tube of the first through third embodiments similarly to the color cathode ray tube of the fourth embodiment, the light absorptivity in the range from 520 nm of the visual range is slightly larger than that of the color cathode ray tube of the first through fourth embodiments. Further, the light transmission color of the present embodiment is a' = -4 to +2 and b' = +5 to +10, and the light transmission colors a' and b' have values smaller than those of the light transmission colors a' and b' of the color cathode ray tube of the fourth embodiment. The appearance of the faceplace 1A of the panel section 1 is evaluated to be almost achromatic color by naked eyes. Still more, the color cathode ray tube of the present embodiment has a surface sheet resistance of about 300 Ω/□, a leaked field strength of 0.4 V/m in ELEF and of 0.4 V/m in VLEF, and fully satisfies the TCO Standard.

Beside them, the color cathode ray tube of the present embodiment has a visual reflectance of 0.6 % and a light transmittance in the visual range of 68 %, and cancels black color of the body color of the color cathode ray tube, caused by the anti-reflection effect, from standing out.

It is noted that although the case in which the silver (Ag) particles are mixed into the conductive high-refractive first layer 14 as the double coating film 5 in the color cathode ray tube of the first through fifth embodiment has been described above, the present invention is not limited to the case when the main component of the conductive high-refractive first layer 14 is the silver (Ag) particles and, beside the silver (Ag), particles of gold (Au), ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os), iridium (Ir), platinum (Pt) and the like or particles into which two or more kinds of those noble metals are mixed may be used.

Further, although the case when the main component of the low-refractive second layer 15 is silicon dioxide (SiO_2)

in the double coating film 5 of the color cathode ray tube of the first through fifth embodiments has been explained, the present invention is not limited to the case when the low-refractive second layer 15 is mainly composed of silicon dioxide (SiO_2) and beside silicon dioxide (SiO_2), magnesium fluoride (MgF_2) may be used.

Further, in the procedure for forming the double coating film 5 on the faceplace 1A in the color cathode ray tube of the first through fifth embodiments, the temperature cited in each Step, i.e. the heating temperature in drying the conductive high-refractive first layer 14 in Steps S7 and S15, the temperature in drying the conductive high-refractive first layer 14 in Step S18, the sintering temperatures in Steps S9, S12, S17 and S20 are all only typical temperatures and the present invention is not limited to those typical temperatures in forming the double coating film 5 on the faceplace 1A.

In this case, the heating temperature in drying the conductive high-refractive first layer 14 in Steps S7 and S15 may be any temperature between 70 and 130°C as described in parenthesis in FIGs. 6 through 8 and the temperature in drying the conductive high-refractive first layer 14 in Step S18 may be any temperature between 45 and 60°C as described in parenthesis in FIG. 9. Further, the sintering temperatures in Steps S9, S12, S17 and S20 may be any temperature between 160 and 175°C as described in parenthesis in FIGs. 6 through 9.

Beside them, although the case when the pigment added to the low-refractive second layer 15 is the anthraquinone blue pigment has been explained in the fifth embodiment of the present invention, the present invention is not limited to the case when the pigment is the anthraquinone blue pigment and other pigments such as dioxarine pigment, phthalocyanine pigment or dye or in addition to the dye and pigments, sillane coupling material or the like may be added.

In each embodiment described above, the conductive high-refractive first layer 14 mainly composed of the metal particles is formed by applying the solution in which the metal particles are dispersed on the faceplace 1A and by drying the solution applied on the faceplace 1A by the drying step after controlling the temperature of the surface of the faceplace 1A by the pre-heating step. Then, the low-refractive second layer 15 is formed by applying the alcohol solution of silicon alkoxide. At this time, the alcohol solution of silicon alkoxide impregnates between the gaps of the metal particles of the conductive high-refractive first layer 14 formed before and reaches the surface of the faceplace 1A. Then, in the following sintering step, silicon oxide (including silicon hydroxide) generated when the silicon alkoxide reacts rigidifies the bonds between the conductive high-refractive first layer 14 and the metal particles, between the metal particles and the faceplace 1A and between the metal particles and the low-refractive second layer 15.

Accordingly, as the final configuration of the double coating film, the conductive high-refractive first layer 14 is composed of the metal particles and silicon oxide as the binder and the low-refractive second layer 15 is made of silicon oxide.

That is, while the layer composed of only the metal particles is formed in the stage when the solution in which the metal particles are dispersed is applied, the conductive high-refractive first layer 14 composed of the metal particles and silicon oxide (including silicon hydroxide) is formed in the end (after sintering) as the alcohol solution impregnates when the alcohol solution of silicon alkoxide is applied. The silicon oxide of this time functions as the binder and increases the closeness of the metal particles (increases contact points), thus enhancing the electrical conductivity. It reduces the gaps among the metal particles and also fills the gaps, thus enhancing the refractivity of the conductive high-refractive first layer 14 further and improving the anti-reflection effect.

Because the metal particles of more than one kind of noble metal elements of gold (Au), silver (Sg) and platinum (Pt) which are chemically stable and are hardly oxidized are used as the metal particles used for the conductive high-refractive first layer 14 in the color cathode ray tube having the field leak preventing coating film of the present embodiment constructed as described above, the surface sheet resistance of the conductive high-refractive first layer 14 may be reduced to a low resistance of less than 1×10^3 Ω/□ and the surface sheet resistance of the conductive high-refractive first layer 14 will not degrade for a long period of time.

Further, because the coloring matters such as the pigments or dyes which is complementary to the coloring of the body color of the cathode ray tube may be added to the low-refractive second layer 15 in the cathode ray tube having the field leak preventing coating film of the present embodiment constructed as described above, the coloring of the body color of the cathode ray tube may be complemented and may be turned into achromatic color.

[Sixth Embodiment]

The present embodiment will be explained by using FIG. 2. In FIG. 2, a surface treatment film 5 comprising a low resistant conductive high-refractive film 14 and a low-refractive film 15 made of silica or the like formed on the conductive high-refractive film 14 is shown. The same reference numerals with those in FIG. 1 correspond to the same components.

In the present embodiment, as the surface treatment film 5 formed on the outer face of the panel section 1 made of glass, the multi-layered structure of the low resistant conductive high-refractive film 14 which is formed under the panel section 1 and in which silver and platinum particles are mixed in a ratio of 2 : 8 and the low-refractive film 15 formed by spin-coating silica on the conductive high-refractive film 14 is adopted. The light transmittance of visual range

of the surface treatment film 5 having such structure is less than 70 %.

[Seventh Embodiment]

The present embodiment will be explained by using FIG. 2. Each reference numeral in FIG. 2 is the same with those in the sixth embodiment. In the present embodiment, as the surface treatment film 5 formed on the outer face of the panel section 1 made of glass, the multi-layered structure of the low resistant conductive high-refractive film 14 which is formed under the panel section 1 and in which silver and rhodium particles are mixed in a ratio of 1 : 9 and the low-refractive film 15 formed by spin-coating silica on the conductive high-refractive film 14 is adopted. The light transmittance of visual range of the surface treatment film 5 having such structure is less than 70 % similarly to the sixth embodiment.

[Eighth Embodiment]

The present embodiment will be explained by using FIG. 3. In FIG. 3, there are shown low-refractive film 15A formed irregularly by spray-coating silica or the like on the low-refractive film 15 formed by spin-coating. The same reference numerals with those in FIG. 2 correspond the same parts or components. In the present embodiment, as the surface treatment film 5 formed on the outer face of the panel section 1 made of glass, the multi-layered structure of the low resistant conductive high-refractive film 14 which is formed under the panel section 1 and in which silver and rhodium particles are mixed in a ratio of 1 : 9, the low-refractive film 15 formed by spin-coating silica on the conductive high-refractive film 14, and the low-refractive third layer 15A irregularly formed by spray-coating silica on the low-refractive film 15 is adopted.

FIG. 13 is a graph showing a relationship between a light transmittance of the surface treatment film in the visual range and a surface resistance thereof according to sixth and seventh embodiment of the present invention, wherein a curve A represents the characteristics of the low resistant conductive high-refractive film in which silver and platinum particles are mixed in the ratio of 2 : 8 and a curve B represents the characteristics of the low resistant conductive high-refractive film in which silver and rhodium particles are mixed in the ratio of 1 : 9.

It can be seen from the curves A and B in FIG. 13 that the surface resistance of the surface treatment film 5 is less than 1×10^3 Ω/□ when the light transmittance in the visual range is less than about 70 %.

Using the surface treatment film 5 in which such low resistant conductive high-refractive film 14 is formed below and the low-refractive film 15 is laminated thereon allows the reflection of external light to be reduced, the electric charge to be prevented and the leak of electromagnetic wave to be remarkably reduced and allows the international guideline (TCO) for restricting the radiation of electromagnetic wave to be readily cleared.

It is noted that it has been found that the visual reflectance at this time (reflectance adapted to the characteristics of human eyes) is less than 1.2 %.

FIG. 14 is a graph showing a result of measurement of the surface resistance of the surface treatment film having the low resistant conductive high-refractive film composing the color cathode ray tube of the invention and an amount of leak of electromagnetic wave.

This measurement result shows a field strength at a distance of 30 cm from the panel face when the color cathode ray tube in which the surface treatment film of the sixth through eighth embodiments is formed is assembled in a set and the low resistant conductive high-refractive film is connected to the ground. In FIG. 14, a straight line C represents the field strength ELEF (V/m) whose frequency is 5 to 2 KHz and below and a straight line D represents the filed strength VLEF (V/m) whose frequency is 2 to 400 KHz.

As shown in FIG. 14, using the low resistant conductive high-refractive film of the sixth through eighth embodiments as the surface treatment film formed on the outer face of the panel of the color cathode ray tube allows the degree of leaked electromagnetic wave to be reduced to the level which is far below the Swedish standard TCO of 10 V/m, the international guideline.

FIG. 15 is a table for explaining the electromagnetic wave leak preventing effect of the surface treatment film of the sixth, seventh and eighth embodiments as compared numerically with the international guideline (TCO of Sweden).

In FIG. 15, it can be seen that the electromagnetic wave leak preventing effects of the sixth and seventh embodiments are both less than 10 V/m, the guideline. Particularly, the both ELEF and VLEF of the sixth embodiment are less than the half of the guideline, showing that the sixth embodiment has a quite large effect for shielding the leaked electromagnetic wave.

Next, a method for forming the surface treatment film provided in the color cathode ray tube of the sixth through eighth embodiments of the present invention will be explained.

[First Example of Method for Forming Treatment Film]

After manufacturing a color display tube having an effective diagonal length of 51 cm and an average transmittance of visual range of the panel of 76 % by the conventional cathode ray tube manufacturing method, a first layer was formed by cleaning the surface of the panel by using abrasive and the like, a solution having the following "Composition 1" was injected and was shaked off for 60 seconds with a number of rotations of 180 rpm so as to have a thickness of less than 0.1 μm while holding the outer face of the panel upward and keeping the surface temperature at 50°C.

It was heated again to dry. Then, a second layer was formed by injecting 50 ml of solution having the following "Composition 2" on the above-mentioned first layer while keeping the temperature of the surface of the panel at 50°C similarly to one described above, by shaking it off for 50 seconds with a number of rotations of 175 rpm and by heating for 30 minutes at 170°C.

As a result, a chemically stable and mechanically strong surface treatment film having a surface resistance of 2 x 10^2 Ω/□, an average transmittance of visual range of 58 % and a visual reflectance of 1.2 % was obtained.

"Composition 1"

silver and platinum (Ag/Pt = 2/8) particle dispersed solution

particles	1.1 wt %
ethyl alcohol	6 wt %
dispersant	0.01 wt %
pur water	remainder

"Composition 2"

Organic sillane alcohol solution

ethoxysillane	0.08 wt %
hydrochloric acid	0.001 wt %
methyl alcohol	remainder

[Second Example of Method for Forming Treatment Film]

The color display tube having an effective diagonal length of 51 cm was manufactured similarly to the above-mentioned first example and a first layer was formed after cleaning the surface of the panel by injecting a solution having the following "Composition 3" and by shaking off for 60 seconds with a number of rotations of 180 rpm so as to have a thickness of less than 0.1 μm while keeping the surface temperature at 50°C.

It was dried and a second layer was formed by injecting 50 ml of solution having the "Composition 2" similarly to the first example while keeping the temperature of the surface at 50°C, by shaking it off for 50 seconds with a number of rotations of 170 rpm and by heating for 30 minutes at 170°C.

As a result, a chemically stable and mechanically strong surface treatment film having a surface resistance of 1 x 10^3 Ω/□, an average transmittance of visual range of 70 % and a visual reflectance of 0.8 % was obtained.

"Composition 3"

silver and rhodium (Ag/Rh = 1/9) particle dispersed solution

particles	0.9 wt %
isopropyl alcohol	10 wt %
dispersant	0.005 wt %
pure water	remainder

[Third Example of Method for Forming Treatment Film]

After forming the double coating film by the same method with the above-mentioned second example of the method for forming the treatment film, the surface of th panel was heated up to 60°C and solution having the following "Composition 4" was sprayed on the whole panel by using a two-fluid nozzle spray gun. It was carried out by scanning the whole surface once under the conditions of 1.8 l/h of flow rate of the solution having the "Composition 4", 180 l/min. of

air flow rate, 30° of spraying angle to the surface of the panel, 30 cm of distance from the spray gun to the surface of the panel and 500 mm/min of sweep speed.

The film formed by the spray was heated for 30 minutes at 170 °C. As a result, a chemically stable and mechanically strong surface treatment film having a surface resistance of 1 x 10^3 Ω/□, an average transmittance of visual range of 70 % and a visual reflectance of 0.9 % and having an appearance similar to a low reflective evaporated film or sputtered film was obtained.

"Composition 4"

Organic sillane alcohol solution

ethoxysillane	1.7 wt %
nitric acid	0.5 wt %
pur water	8.0 wt %
ethyl alcohol	remainder

It is noted that the cases of using the particles in which platinum and rhodium or silver are mixed have been explained in the sixth through eighth embodiments and the methods for forming the treatment film of the first through third examples, the present invention is not limited only to those cases and a sole substance of rubidium, palladium, iridium, osmium and the like or a mixture of two or more of those substances, or particles in which rubidium, palladium, iridium, osmium and the like is mixed with silver may be used

Because electrical resistance of such noble metals of rubidium, palladium, iridium and osmium are all within a range of 10^{-5} to 10^{-6} Ω·cm, which is several to ten-odd times of silver, the mixing ratio may be decided corresponding to the resistance when they are mixed with silver. However, it is preferable to set the mixing ratio of silver to be about 10 % in view of the practical stability.

According to the sixth through eighth embodiments of the present invention described above, the cost for forming the treatment film on the outer face of the panel may be lowered considerably as compared to that of the sputtering or the NESA coat forming method.

FIG. 16 is a table for explaining the cost for forming the surface treatment film of the sixth through eighth embodiments of the present invention as compared to the cost for forming the sputtered film and a NESA coat. As shown in this table, when the cost is assumed to be 100 in forming the sputtered film, the cost of the NESA coat is 50 and that of the low resistant conductive high-refractive film of the sixth through eighth embodiments of the present invention is 25. That is, the high performance surface treatment film may be obtained at low cost.

Next, the transmittance of the color cathode ray tube of the sixth through eighth embodiments of the present invention will be explained by comparing with that of the prior art color cathode ray tube.

FIG. 17 is a schematic section view of a panel for explaining a transmittance of the panel of the color cathode ray tube, comprising the panel section 1 made of glass and the treatment film 5 formed on the outer face thereof.

Here, when a transmittance of the glass of the panel section 1 is T_0 and a transmittance of the treatment film is T_1, a transmittance of the whole panel forming the treatment film (total transmittance) may be expressed as $T = T_0 \times T_1$. Here, the transmittanc T of the whole panel having the treatment film and the transmittance T_0 of the underlying panel may be measured by referencing air and the transmittance T_1 of the treatment film is measured by the transmittance of

k_1 is absorption coefficient (mm^{-1}) of the panel glass,
k_2 is absorption coefficient (mm^{-1}) of the surface treatment film,
t_1 is a thickness of the panel glass,
and t_2 is a thickness of the surface treatment film.

FIG. 18 is a table for explaining a transmittance of various glass materials for composing the panel, a transmittance of only the treatment film formed thereon and a transmittance (total transmittance) of the treatment film and the glass in total.

The transmittance of the panel when its absorption coefficient is 0.0058 mm^{-1} and when it has a clear ground of 13 mm in thickness is 85 % and the total transmittance when the treatment film having a transmittance of 50 % is formed thereon turns out to be 43 %.

The transmittance of the panel when its absorption coefficient is 0.0014 mm^{-1} and when it has a semi-clear ground of 13 mm in thickness is 76 % and the total transmittance when the treatment film having a transmittance of 50 % is formed thereon turns out to be 38 %. Further, when a treatment film having a transmittance of 60 % is formed on the panel of the semi-clear ground, the total transmittance turns out to be 46 % and when a treatment film having a transmittance of 66 % is formed similarly on the panel of the semi-clear ground, the total transmittance is 50 %.

The transmittance of the panel when its absorption coefficient is 0.0022 mm^{-1} and when it has a gray ground of 13 mm in thickness is 69 % and the total transmittance when the treatment film having a transmittance of 62 % is formed thereon turns out to be 43 % and when a treatment film having a transmittance of 67 % is formed on the panel of the gray ground, the total transmittance turns out to be 46 %.

Meanwhile, the present color cathode ray tube uses a tinted panel or a dark tinted panel is used for the panel glass and a treatment film having a transmittance of 86 to 100 % is formed on the outer face thereof.

FIG. 19 is a table for explaining a transmittance of a prior art color cathode ray tube of a high-contrast type. When the panel is made of tinted glass, a total transmittance turns out to be 43 to 46 % when a transmittance of the tinted glass is 50 % and a treatment film having a transmittance of 86 to 92 % is formed on the tinted glass. When the panel is made of dark tinted glass, a total transmittance turns out to be 38 % when a transmittance of the dark tinted glass is 38 % and a treatment film having a transmittance of 100 % is formed on the dark tinted glass.

While 46 % of total transmittance is the general standard of the prior art color cathode ray tube of this kind, the color cathode ray tube having a total transmittance of around 46 % may be constructed by forming the above-mentioned inventive treatment film by using the clear panel, semi-clear panel or gray panel shown in FIG. 18.

Thus, the embodiments of the present invention allow the color cathode ray tube which prevents the reflection of external light and the electric charge and reduces the leakage of electromagnetic wave considerably as compared to the international standard to be obtained at low cost.

While preferred embodiments have been described, variations thereto will occur to those skilled in the art within the scope of the present inventive concepts which are delineated by the following claims.

Claims

1. A color cathode ray tube, comprising:

   a vacuum case comprising a panel section (1), a neck section (2) and a funnel section (3) connecting said panel section and said neck section;
   a fluorescent film (4) applied on an inner face of said panel section; and
   an electron gun (12), stored in said neck section, for emitting three electron beams (13) toward said fluorescent film;
   said color cathode ray tube further comprising a field leak preventing coating film (5) obtained by adhering a double coating film composed of a conductive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and a second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) on an outer fac of a faceplate of said panel section.

2. The color cathode ray tube according to Claim 1, wherein a refractive index of said conductive first layer of said field leak preventing coating film is greater than a refractive index of said second layer.

3. The color cathode ray tube according to Claim 1, wherein an average light transmittance of visual range of said conductive first layer of said field leak preventing coating film is 50 to 90 %.

4. The color cathode ray tube according to Claim 1, wherein a surface resistance of said conductive first layer of said

field leak preventing coating film is less than 1 x 10^3 Ω/□.

5. A color cathode ray tube, comprising:

a vacuum case comprising a panel section (1), a neck section (2) and a funnel section (3) connecting said panel section and said neck section;
a fluorescent film (4) applied on an inner face of said panel section; and
an electron gun (12), stored in said neck section, for emitting three electron beams (13) toward said fluorescent film;
said color cathode ray tube further comprising a field leak preventing coating film (5) obtained by adhering a double coating film composed of a conductive high-refractive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt), a low-refractive second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) formed on said conductive high-refractive first layer and a low-refractive third layer (15A) having irregular surface formed on said low-refractive second layer on an outer face of a faceplate of said panel section.

6. The color cathode ray tube according to claim 5, wherein an average light transmittance of visual range of said conductive first layer of said field leak preventing coating film is 50 to 90 %.

7. The color cathode ray tube according to Claim 5, wherein a surface resistance of said conductive first layer of said field leak preventing coating film is less than 1 x 10^3 Ω/□.

8. A color cathode ray tube, comprising:

a vacuum case comprising a panel section (1), a neck section (2) and a funnel section (3) connecting said panel section and said neck section;
a fluorescent film (4) applied on an inner face of said panel section; and
an electron gun (12), stored in said neck section, for emitting three electron beams toward said fluorescent film;
said color cathode ray tube further comprising a field leak preventing coating film (5) obtained by adhering a double coating film composed of a conductive high-refractive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and having irregularities on the surface thereof and a low-refractive second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) on an outer face of a faceplate of said panel section.

9. The color cathode ray tube according to Claim 8, wherein an average light transmittance of visual range of said conductive first layer of said field leak preventing coating film is 50 to 90 %.

10. The color cathode ray tube according to Claim 8, wherein a surface resistance of said conductive first layer of said field leak preventing coating film is less than 1 x 10^3 Ω/□.

11. A color cathode ray tube, comprising:

a vacuum case comprising a panel section (1), a neck section (2) and a funnel section (3) connecting said panel section and said neck section;
a fluor scent film (4) applied on an inner face of said panel section; and
an electron gun (12), stored in said neck section, for emitting three electron beams toward said fluorescent film;
said color cathode ray tube further comprising a field leak preventing coating film (5) obtained by adhering a double coating film composed of a conductive high-refractive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and whose surface resistance is less than 1 x 10^3 Ω/□ and a low-refractive second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) laminated on said conductive high-refractive first layer and containing a coloring matter showing a selective absorbing characteristic in the visual range on an outer face of a faceplate of said panel section.

a fluorescent film (4) applied on an inner face of said panel section; and

an electron gun (12), stored in said neck section, for emitting three electron beams toward said fluorescent film; said color cathode ray tube further comprising a field leak preventing coating film (5) obtained by adhering a double coating film composed of a conductive high-refractive first layer (14) mainly composed of particles of one or more kinds of metal among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) and a low-refractive second layer (15) mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) on an outer face of a faceplate of said panel section;
an average light transmittance of the visual range of said field leak preventing coating film being 45 to 80 % and a surface resistance thereof being less than 1.6×10^3 Ω/□.

13. The color cathode ray tube according to Claim 12, wherein said conductive first layer of said field leak preventing coating film made of the noble metal element contains either one of platinum, rhodium, rubidium, palladium, iridium and osmium.

14. The color cathode ray tube according to Claim 12, wherein said conductive first layer of said field leak preventing coating film contains noble metal elements of silver (Ag) and platinum (Pt).

15. A color cathode ray tube, comprising:

a vacuum case comprising a panel section (1), a neck section (2) and a funnel section (3) connecting said panel section and said neck section;
a fluorescent film (4) applied on an inner face of said panel section;
an electron gun (12), stored in said neck section, for emitting three electron beams toward said fluorescent film; and
a field leak preventing coating film (5) on the outer face of a faceplate of said panel section;
said field leak preventing coating film being fabricated through steps of:
applying a dispersed solution mainly composed of particles of one or more metals among noble metal elements of gold (Au), silver (Ag) or platinum (Pt) on the outer face of a faceplate of said panel section;
forming a conductive high-refractive first layer on the outer face of said faceplate on which said dispersed solution has been applied and dried;
coating a low-refractive second layer by applying alcohol solution mainly composed of silicon dioxide (SiO_2) or magnesium fluoride (MgF_2) on said conductive high-refractive first layer; and
forming said low-refractive second layer on the out r face of said faceplate after coating said low-refractive second layer by heating it.

16. The color cathode ray tube according to Claim 15, wher in said field leak preventing coating film is fabricated by a

FIG. 1

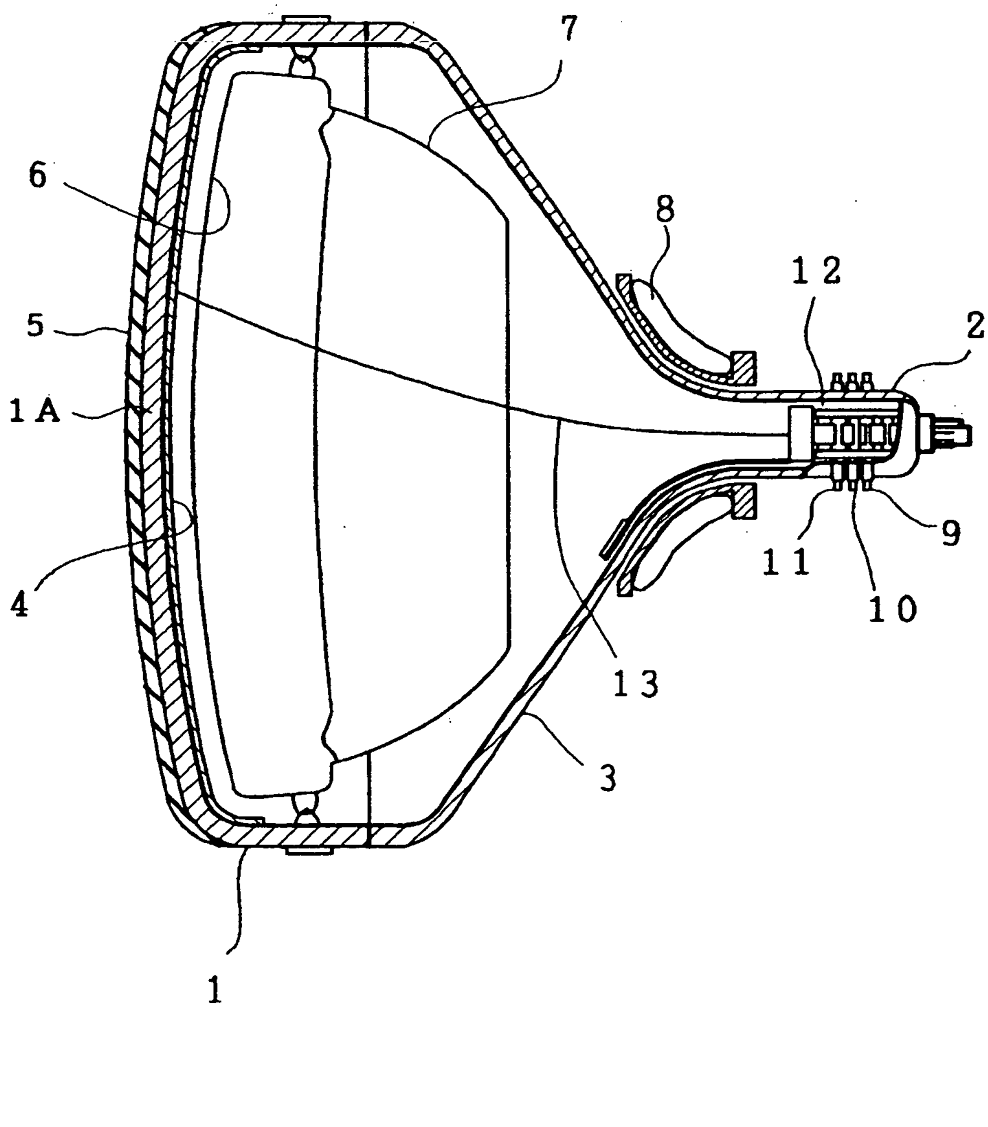


FIG. 2

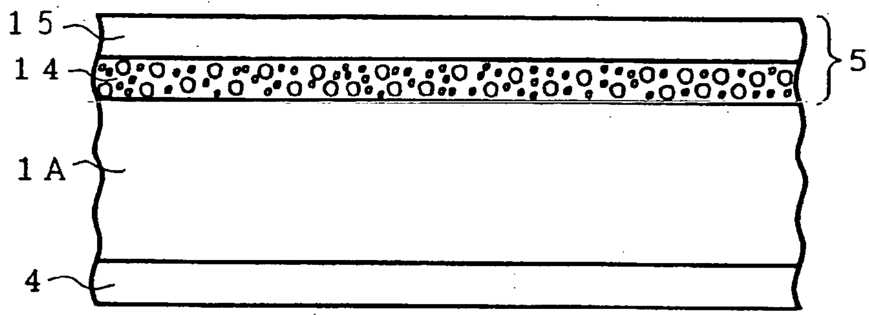


FIG. 3

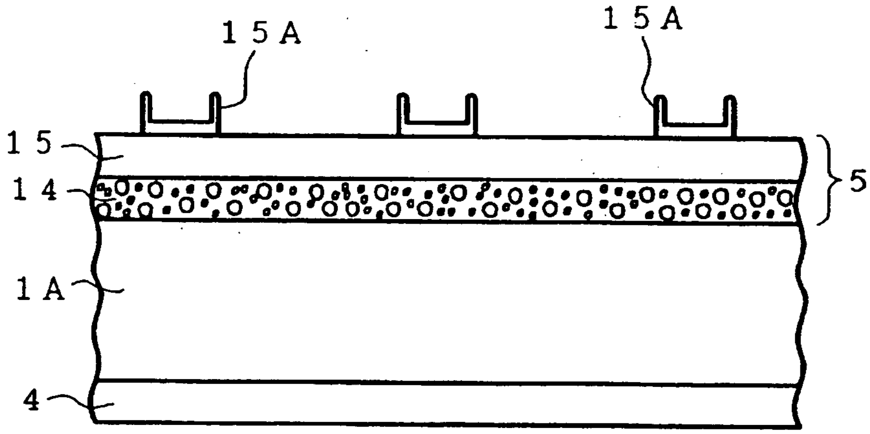


FIG. 4

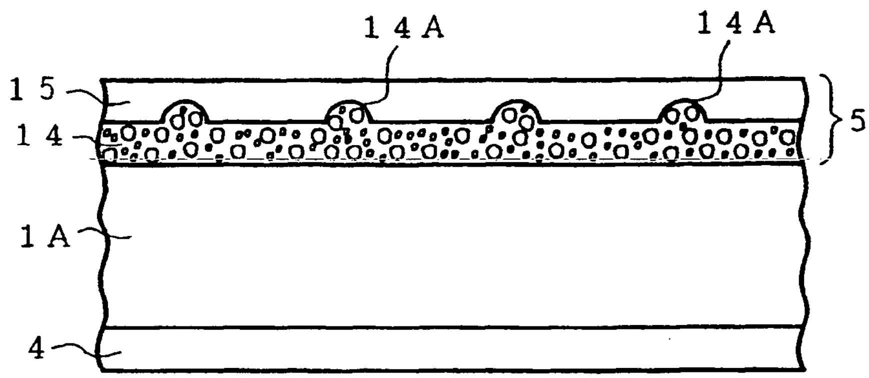


FIG. 5

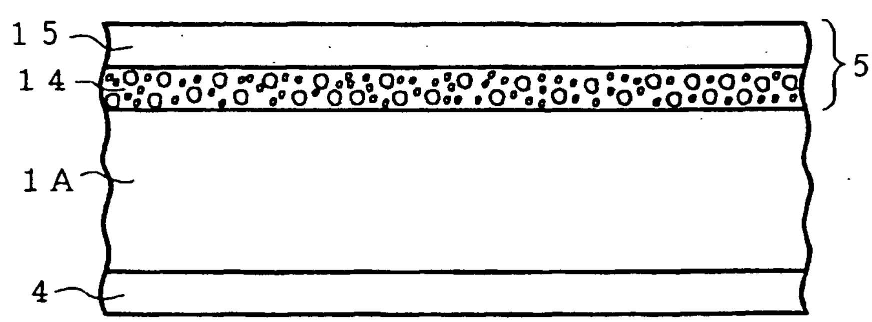


FIG. 6

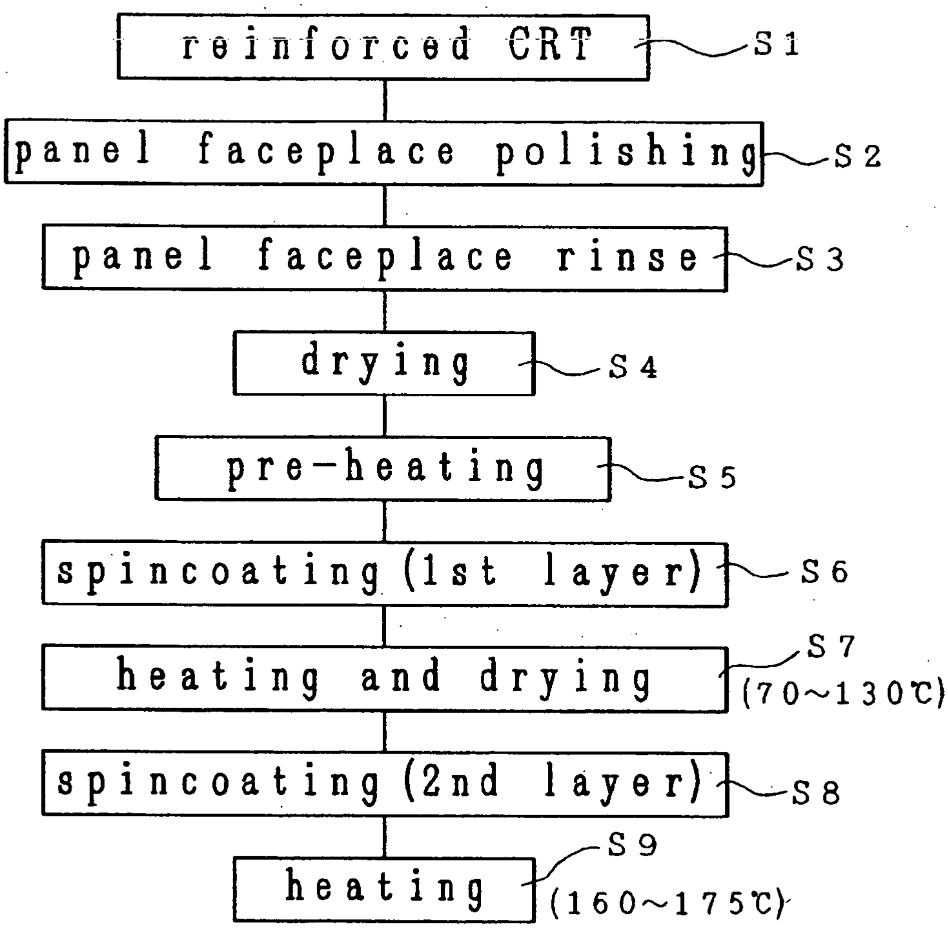

reinforced CRT
S1
panel faceplace polishing
S2
panel faceplace rinse
S3
drying
S4
pre-heating
S5
spincoating (1st layer)
S6
heating and drying
S7
(70~130℃)
spincoating (2nd layer)
S8
heating
S9
(160~175℃)

FIG. 7

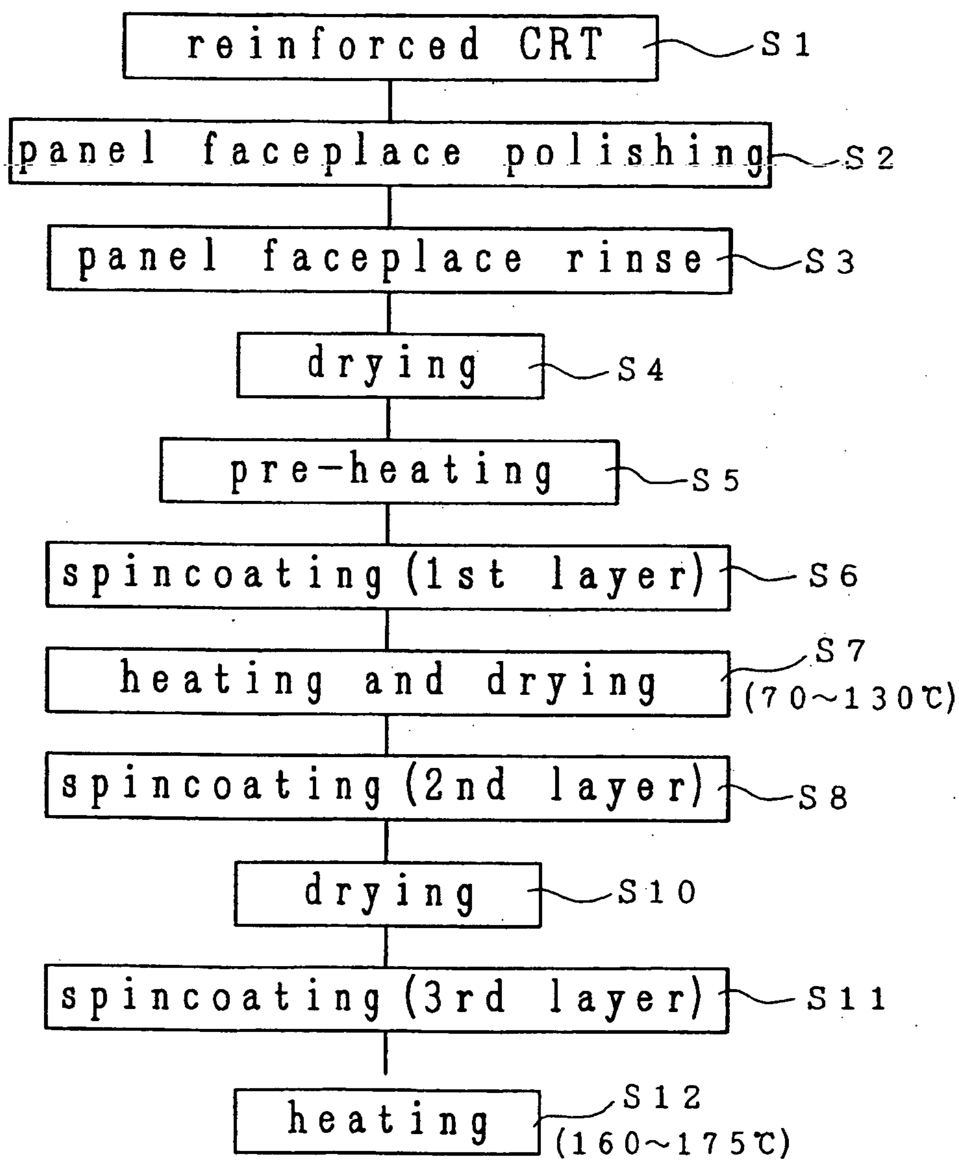

reinforced CRT
S1
panel faceplace polishing
S2
panel faceplace rinse
S3
drying
S4
pre-heating
S5
spincoating (1st layer)
S6
heating and drying
S7
(70~130℃)
spincoating (2nd layer)
S8
drying
S10
spincoating (3rd layer)
S11
heating
S12
(160~175℃)

FIG. 8

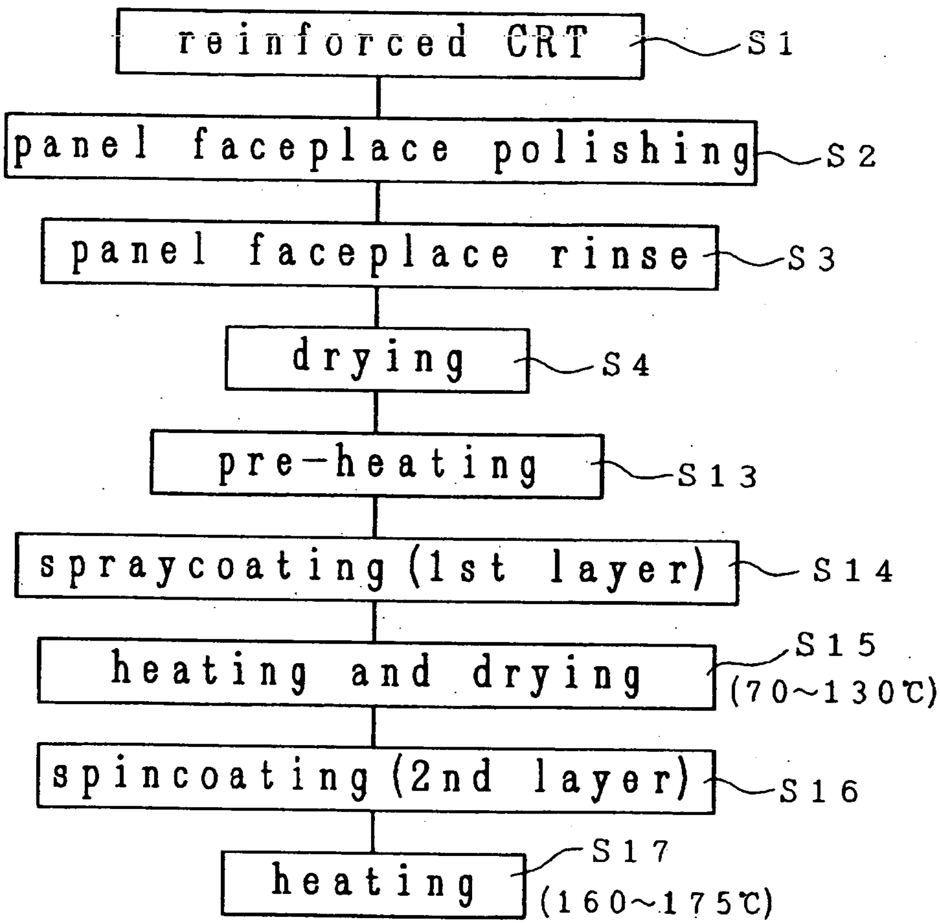

reinforced CRT
S1
panel faceplace polishing
S2
panel faceplace rinse
S3
drying
S4
pre-heating
S13
spraycoating (1st layer)
S14
heating and drying
S15
(70~130℃)
spincoating (2nd layer)
S16
heating
S17
(160~175℃)

FIG. 9

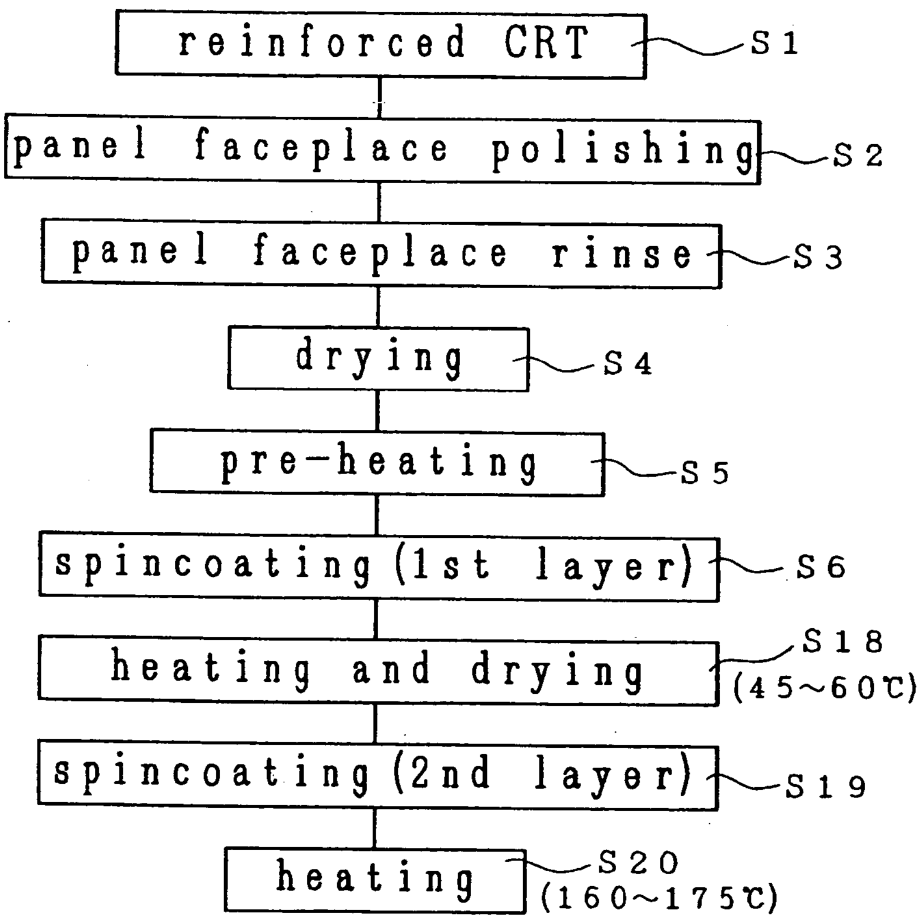

reinforced CRT
S1
panel faceplace polishing
S2
panel faceplace rinse
S3
drying
S4
pre-heating
S5
spincoating (1st layer)
S6
heating and drying
S18
(45~60℃)
spincoating (2nd layer)
S19
heating
S20
(160~175℃)

FIG. 10

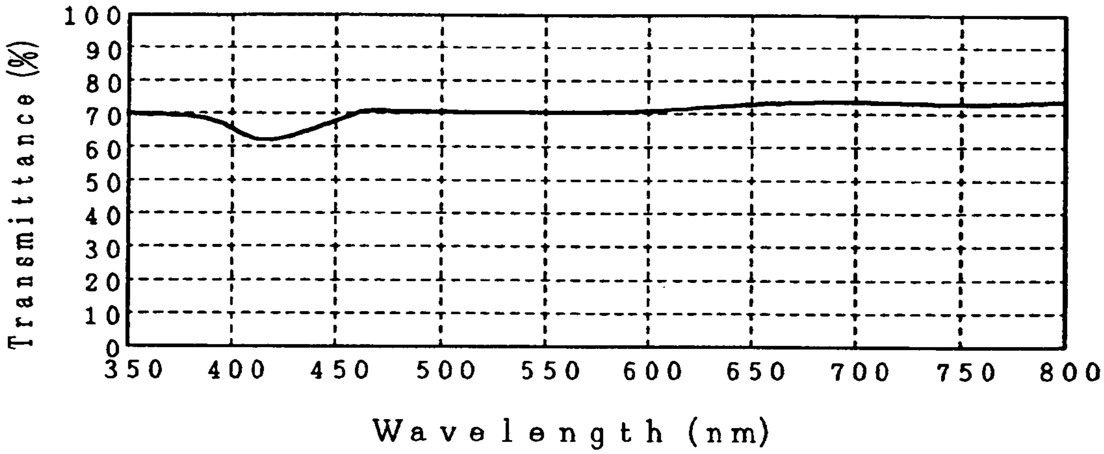


FIG. 11

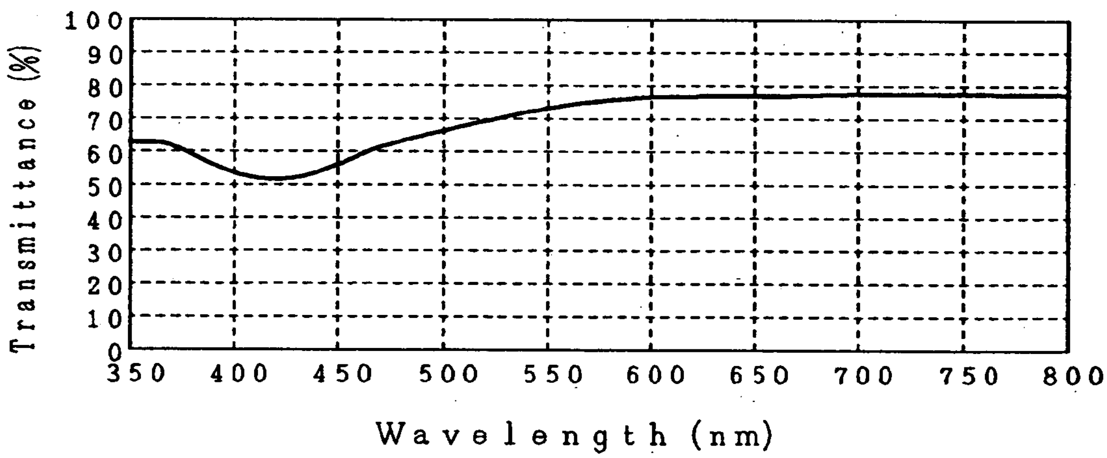


FIG. 12

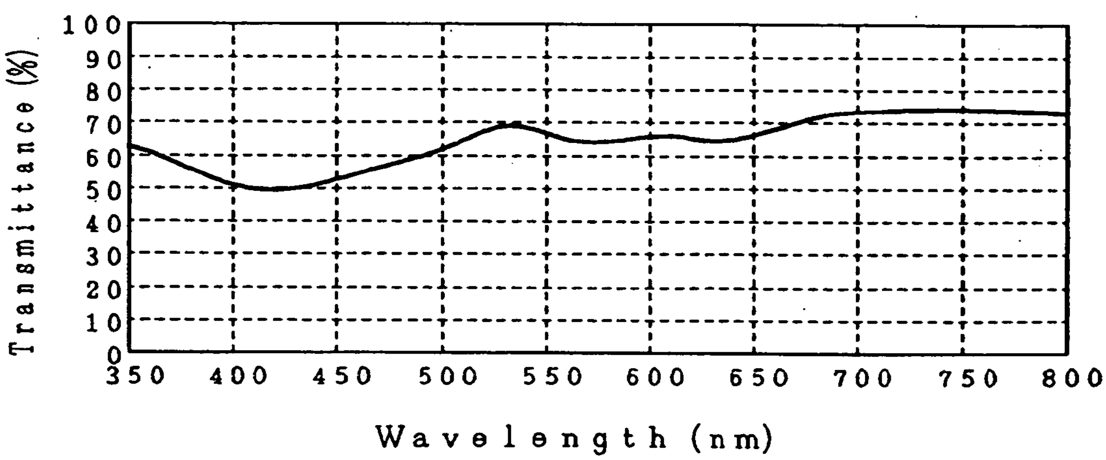


FIG. 13

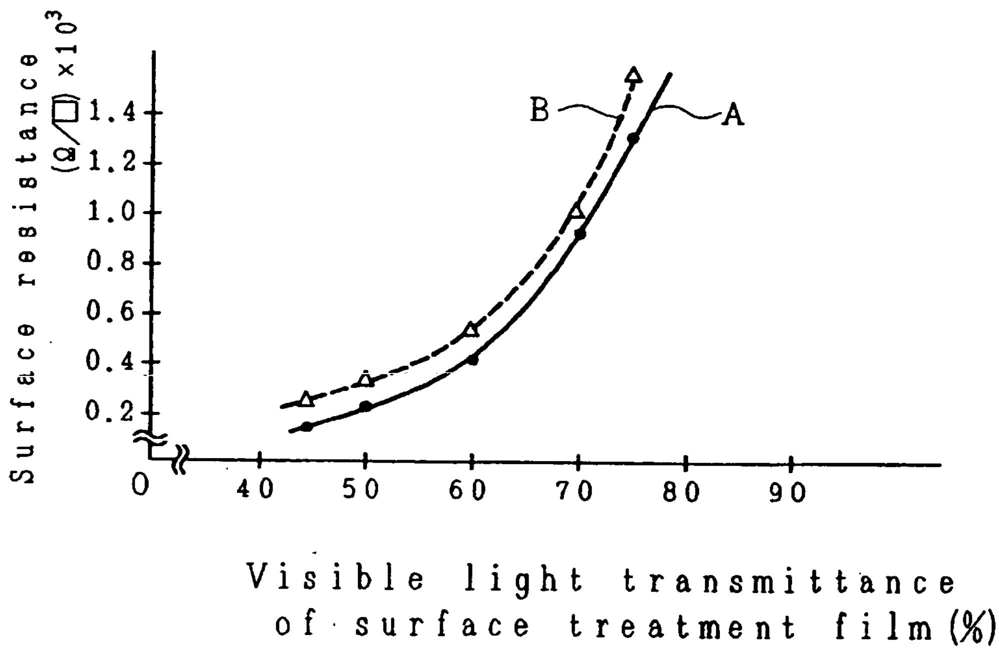

Surface resistance (Ω/□) ×10³
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
40
50
60
70
80
90
B
A
Visible light transmittance of surface treatment film (%)

FIG. 14

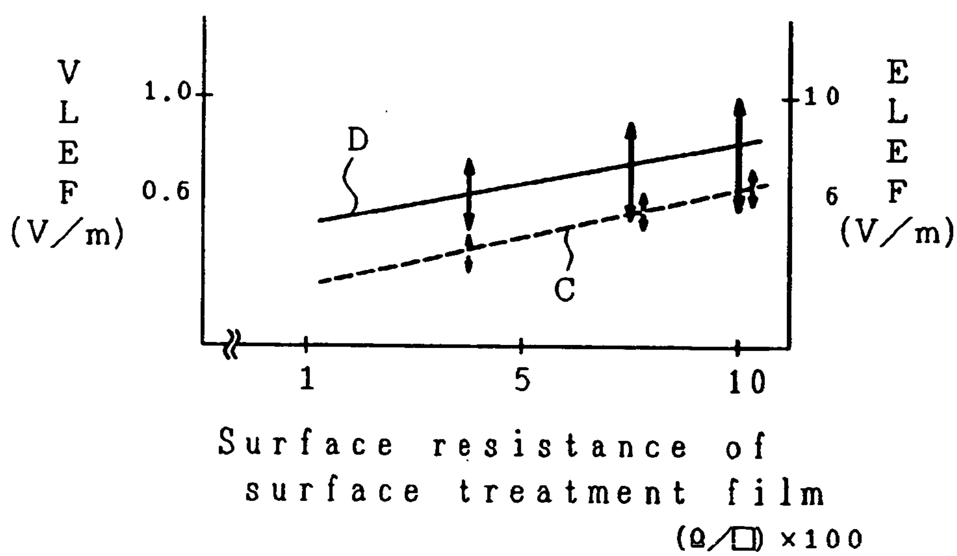

VLEF (V/m)
1.0
0.6
ELEF (V/m)
10
6
D
C
1
5
10
Surface resistance of surface treatment film (Ω/□) ×100

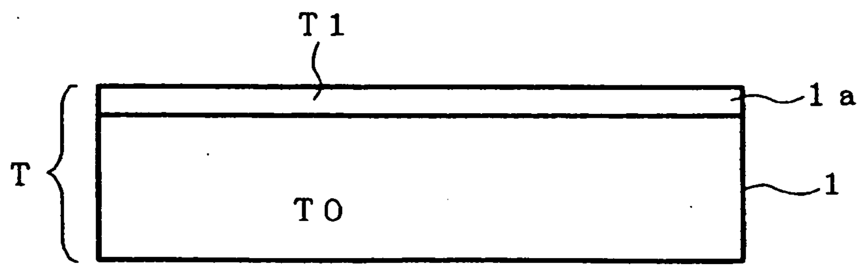
FIG. 15

	ELEF (5～2kHz)	VLEF (2k～400kHz)
Embodiment 1	3.4V/m	0.4V/m
Embodiment 2	7.8V/m	0.9V/m
Guideline	less than 10V/m	less than 10V/m

FIG. 16

	Sputtered film	NESA film	this investment
Cost	100	40	25

FIG. 17



T=T0×T1

FIG. 18

	Transmittance of panel (T0)	Transmittance of surface treatment film (T1)	Total transmittance of panel (T)
Clear panel	85%	50%	43%
Semi-clear panel	76%	50%	38%
		60%	46%
		66%	50%
Gray panel	69%	62%	43%
		67%	46%

FIG. 19

	Transmittance of panel (T0)	Transmittance of prior art's surface treatment film (T1)	Total transmittance of panel (T)
tinted panel	50%	86～92%	43～46%
dark tinted panel	38%	100%	38%

European Pat nt Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 2436

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP 0 649 160 A (PHILIPS ELECTRONICS NV) 19 April 1995 * claim 2; figure 2 * * page 3, line 57 - page 4, line 2 * * page 5, line 7 - line 16 *	1,5,8, 11,12,15	H01J29/86
Y	EP 0 533 255 A (PHILIPS NV) 24 March 1993 * column 4, line 20 - line 35 *	1,5,8, 11,12,15	
A	EP 0 356 229 A (RCA LICENSING CORP) 28 February 1990 * column 3, line 55 - line 62 *	1,5,8, 11,12,15	
A	GB 2 161 320 A (RCA CORP) 8 January 1986 * page 1, line 46 - line 51 *	1,5,8, 11,12,15	
A	H TOHDA ET AL.: "Anti-glare, anti-reflection and anti-static (AGRAS) coating for CRTs" THE TWELFTH INTERNATIONAL DISPLAY RESEARCH CONFERENCE - JAPAN DISPLAY 92, 12 - 14 October 1992, HIROSHIMA, JP, pages 289-292, XP002065272 * the whole document *	1,5,8, 11,12,15	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01J
D,A	US 5 412 278 A (IWASAKI YASUO) 2 May 1995 * column 2, line 12 - line 21 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 May 1998	Colvin, G

CATEGORY OF CITED DOCUMENTS

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